

Using Constructive Learning to Meet the Learning Needs of Students in the Urban Charter

School Setting

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Abstract

I have been working with urban Arizona students for almost 10 years. These students receive less support than their non-urban counterparts in the public school system. Many underperforming students find their way into schools of choice: charter schools (Garcia, 2008). Most need intensive intervention, yet they find their way to computer-based education charter schools. These students are served by fewer hands-on resources and less experienced educators. Project-Based Learning (PBL) was added to compare student learning to the existing delivery. The results demonstrated a significant increase of student improvement. The class using the added PBL approach showed an average 71% increase in 60 hours of coursework as evidenced by the school's pre-and post-assessment for algebra readiness. Student passing rate increased from 46% using mastery-based learning alone to 82% with a combined approach of mastery-based and PBL methodologies.

Introduction

Students in urban high schools are at a disadvantage (Lynch, 2000). Resources are limited (Darling-Hammond, 2010; Gibbons, 2012) and the students who attend these schools are typically lacking in the home support (Parrett & Budge, 2012) that their suburban and private school counterparts enjoy. Many of these students fail to complete high school on time (Chapman, Laird, & KewalRamani, 2013).

Many urban students are poor and classified as “non-dominant” (Seiler, 2013). The school setting, as in most of American society, has been structurally shaped by the industrial organizations that employ the bulk of the country’s labor force. This structure, which has been created by the white male, confers certain power and bias toward this same group of White males of privilege. This collective influence is called “dominant”. It precedes and extends throughout the underlying structure of corporate America, which includes the education system. Those without this white maleness characteristic do not have a share in this underlying advantage and are termed “non-dominant” (Calvert & Ramsey, 1996).

Arizona Education Landscape

In Arizona, the on-time graduation rate is 67.2% (Creno, 2013). Many of the remaining students who do not graduate on time pass through the doors of charter schools ("Dropout factories," 2007). Currently, Arizona has 602 charter schools that serve more than 16% of the state student population ("About Charter Schools," 2013). Many of these students are placed in computer-based instruction-oriented charter schools such as e-Institute, Intelli-School, Life Skills, or online offerings such as Primavera Online and K12.com. This mastery-based, self-regulating approach is challenging for even the best students (Kim, Kim, & Karimi, 2012).

Self-regulated independent learning is a daunting challenge for students who are impoverished, highly transient, and lack parental support (Evans, 2004). Instead of redacting the learning environment to one student in front of a computer screen, the opposite is indicated. Students in urban environments need more support and interaction with peers. Accessing a student's fund of knowledge is a critical component to making the learning a meaningful activity (Lynch, 2000).

Urban charter high school students need to have an equitable learning environment to close the learning gap with their suburban peers. They require additional support to help them overcome the daily obstacles that impact their lives (Lynch, 2000; Martin, 2013; Tobin, Elmesky, & Seiler, 2005). Arizona law permits charter schools to use uncertified instructors in both core and elective classrooms (LexisNexis, 2012). Special education teachers must be appropriately certified, but the remaining instructors have no requirements for certification beyond those imposed by the federal No Child Left Behind Act (*2012–2013 Arizona Guidance for Title II-A*, 2012, pp. 11 -12).

Students perform better when their voice is heard and developed (Wolk & Peake, 1998). When students can express themselves in a learning context, it makes the learning more meaningful. This process of accommodating a student's voice, making the content relevant and having them close the learning gap, is not possible within a setting where the focus is on "accelerated credits."

Many of the students who attend my charter school are attracted by the advertised ability to complete up to two full years of high school credit within one fiscal school year. This is accomplished by reducing the courses to the minimum number of calendar days. This, in turn creates multiple semester terms within a given school year.

Many of these students have become fossilized in their educational skills. They do not recognize relevance in learning basic math skills. As these students have progressed through the elementary and middle school grades, many of them have been socially promoted regardless of competency. All of the students in my pre-algebra class had a scaled score under 30 on the administered A+LS Grade 8 Math adaptive assessment. A minimum scaled score of 30 is necessary to show readiness for high school mathematics.

High student transiency is a significant factor in my school's attendance. The school is situated in West Phoenix in a very low SES community. Last year, the school enrolled over 1,300 students but maintained a daily attendance of just fewer than 375 students. The remaining 975 simply stopped attending or else they withdrew to attend elsewhere. The school's charter permits students to enroll and attend classes until they age out at 21.

Over 90% of the students qualify for free or reduced lunch. Student ethnic composition is 85% Hispanic, 7% African or African-American, 5% White and the remainders are Native American (Apache, Tohono O'Odham, Navajo). Approximately 20% of the student population is not native born to the United States. More than 20% speak another language instead of English at home, qualifying them as English Language Learners.

Approximately 25% of my pre-algebra class have Individual Education Plans (IEP) and five of the seven students have been identified as Specific Learning Disabled (SLD). Several of the students entitled to special education services are using this class as a modification for a core mathematics course. All of the SLD students have an additional modification of 50%, instead of 70% correct, as their minimum passing score for credit.

Accelerated School Structure

Each student may enroll in four courses every seven weeks, which offers the opportunity to complete 20 semester length courses during the school year. This translates to 10 Carnegie Units of high school education. Arizona graduation requires a student to successfully pass the three standardized state examinations (Reading, Writing and Mathematics) and complete 22 Carnegie Units.

This shortened timeframe produces less than desirable results for many students who struggle with content material. During the last school year, students at my high school successfully completed approximately 24% of the courses attempted. The condensed schedule, combined with a significant daily absentee rate, creates a challenge to accrue these accelerated credits.

Boykin and Noguera describe the dilemma by stating, “We have a long history in this country of pursuing ‘quick-fix’ reforms – phonics-based reading programs, smartboards and computer-based learning programs, scripted curricula, ‘teacher-proof’ curricula – that promise a great deal but often seem to deliver little” (Boykin & Noguera, 2011, p. 1).

Instead of creating a successful learning environment for these students, many of them accumulate large numbers of failed courses. What is needed for these students is more support (Parrett & Budge, 2012; Somers, Owens, & Piliawsky, 2009).

Using Projects to Enhance Engagement

Urban students can close the learning gap in the urban science and mathematics setting by having hands-on activities added to the classroom setting (Billig, Jaime, Abrams, Fitzpatrick, & Kendrick, 2005; Martin, 2013). These activities are different than the scripted materials because they keep the teacher in charge of the learning process. Projects are selected, prepared and guided by the classroom teacher and adjusted based upon formative assessment and student

feedback. My mathematics projects typically use cross-curricular content to make the learning relevant and stimulate engagement and not simply computation or skill building. There is a high correlation between engagement and bringing children up to grade level (Boykin & Noguera, 2011).

Many studies focus on large matriculating high schools and not on the smaller schools of choice where charter schools fill the niche. The charter schools of choice were designed with the intent to provide flexibility and a faster response to student needs than the traditional “big box” high school of the last century. My charter high school was recently transferred to a new charter holder who abandoned the traditional classroom approach in favor of using a hybrid approach where teachers use an online learning system as a substitute for a textbook. To facilitate a faster credit accrual process, the amount of time for one Carnegie Unit of learning was pared to the minimum 120 hours. Carved into 60 blocks of two hours each, the charter school student spends 60 school days earning a full credit. Public school counterparts, by comparison, earn the same credit in 55-minute blocks over 180 school days.

A charter school class lesson is sectioned into a three-part presentation using the A+nywhere Learning System (A+LS) in one-hour increments and called a lesson. The first part is a brief written study section that is concisely written and presented in 10 – 25 screens of text and examples. In many cases, the classroom teacher introduces the material by displaying the study content and adds comments and observations. Students are encouraged to take notes on the information on the board so they can refer to it when practicing and taking the lesson quiz. In the second part of the lesson, students open individual netbook computers that permit them to work individually on their material through A+LS individual accounts. The practice phase provides and records 10 practice exercises to complete. Our program is set to have them work

the 10 exercises to a place where they show at least 70% mastery of the exercises. Students then move on to the mastery test for the content. This third component of the lesson is a ten-question quiz called a mastery test. Questions are drawn from the system's internal question banks. They have up to a maximum of four attempts to score the required minimum of seven correct answers. Usually, many questions are identical to ones that were presented in the practice session. The purpose for the computerized assessments is two-fold. First, it standardizes the content for all students equally. Second, it enables rapid feedback to both the teacher and the student.

Students are expected to self-regulate themselves through two full lessons within the daily two-hour block of class time. A student is expected to demonstrate a 70% minimum mastery on each topic within the one-hour time frame without regard to difficulty or the student's skill levels. Students must successfully complete 55 assignments for the first semester of Pre-Algebra A in a 30 school-day term. As a school, there is an expectation that 70% of all students should successfully complete the math courses. Last year, 75% of the school's Algebra 1 students failed to successfully pass the course. The pre-algebra course had 54% of its students fail to earn a passing grade and credit.

Several studies have indicated that reorganizing the urban math classroom along constructivist learning theory can close the gap ("NAEP State Comparisons ", 2011) between Hispanic students and their White counterparts. Using a project-based learning pedagogy is expected to improve the performance of these students.

As an academic practitioner in a smaller (less than 500 students) charter high school in Phoenix, Arizona, I became interested in the possible benefits of adding a hands-on project to my pre-algebra classroom that would be relevant to the students of West Phoenix. I wanted to

increase student engagement and interest through the use of context- relevant materials pertaining to mathematics content.

I compared data from last year's pre-algebra course, which was administered by a highly qualified mathematics teacher at the school, with a comparable group of students in the following term. The teacher's practice was from the behaviorist theory and used the delivery structure described above incorporating the school online curriculum delivery system, A+LS. The learning system application is exclusively mastery-based learning. The program is based upon Gagne's Learning Theory and showed mixed results with my school's students. It should be noted that the publisher's literature recommends the offerings be used for intervention support and credit recovery situations. These are the stated purposes from the company literature. My school site uses it differently.

The school board adopted the A+LS as the primary replacement for textbooks, and it is used as the primary textbook for all of the school's courses. Most of the courses are used in a stand-alone mode where a teacher can be remotely involved through a third-party communication application that interfaces with the A+LS system. In these classes, students are supervised by a paraprofessional who is not the teacher of record.

Core graduation courses are generally handled with a highly qualified teacher in a classroom. However, A+LS can deliver all of the content, assessments and summative tests for the course. A teacher may override this structure at any time. However, there are few alternatives at the school for textbooks and support materials. There are foundational courses for math and reading that are generally self-paced A+LS assignments with paraprofessionals supervising the school's 50-station computer lab.

I inserted several project-based learning activities into the classroom structure. I served as the daily classroom teacher for my students. My scaffolding activities were a mixture of A+LS, online selections and just plain teaching. My intent was to accelerate the algebra readiness for underperforming high school students in the West Phoenix urban environment. The use of hands-on projects has shown to increase science learning (Tal, Krajcik, & Blumenfeld, 2006) and was expected it would reengage learners of mathematics. I implemented workgroups to leverage and accelerate learning for students who were identified as not ready for high school algebra. Students who scored less than 30 using the end-of-year Grade 8 formative assessment from A+LS were considered unprepared for high school mathematics and placed in the remediation program. As a part of this process, I requested and was assigned 32 of the 37 eligible students for this class. The remaining students were assigned to the A+LS curriculum in the school computer lab with a paraprofessional supervising the class.

Method

My first requirement was to determine where the students needed the most help in preparing for high school algebra. I accomplished this task by having the students complete an initial inventory of skills using our learning system's adaptive assessment program. This test quickly assesses students for skills needed for entry into a first-year algebra class. The data indicated a majority of students lacked a basic understanding of rational numbers and how to manipulate numbers in general.

The students also filled out an attitude survey (see Appendix A) to determine their predisposition to mathematics in general. This survey returned results that showed the students liked math, but did not understand how algebra is organized. They also were unable to link

mathematics and other areas of their lives. One comment which came up many times was, “When will I ever need this stuff?”

The assessments revealed two areas for focus and improvement. The first set involved rational numbers to include fractions, decimals, and percent. The second area centered on the properties of signed numbers. The students showed confusion about the differences between the addition and multiplication properties. They also did not understand how operations of subtraction and division worked. Compounding this situation was an observable misunderstanding of how signed numbers related to number line activity and number theory in general. A number of students were also deficient in their basic math facts, such as multiplication of sixes, sevens, eights, and nines. They were also unable to add sums larger than seven without the use of fingers or calculators. The basic fact deficiencies were not uniform. In order to expedite the scaffolded learning, I provided scientific calculators or permitted the students to bring their own devices, which included calculators embedded in cellphones

Because the students had not made a connection with academic mathematics, I chose to use a mixture of behaviorist and constructivist theories to bridge the learning and relevancy gap for the students. The use of behaviorist material and learning would be used in the scaffolding components of instruction. This included using mathematical formulas and note-taking instruction with the Cornell Notes format (Donohoo, 2010) as a way to organize notes for the students to receive additional scaffolding support for their skills development. I incorporated Gagne’s Intellectual Skills and Cognitive Strategies (Driscoll & Driscoll, 2005, pp. 358-363) to drive the learning for the specific properties of rational numbers, fractions, proportions and signed numbers. I incorporated direct instruction lessons with significant practice embedded into these topics. The lessons were designed to focus the student on the use of addition, subtraction,

multiplication, and division of fractions; using and manipulating numbers through the cross-product multiplication property of proportions; and the addition, subtraction, multiplication and division properties of signed numbers.

All students participated in these instructional activities, which were delivered as discrete lessons. Lesson presentations were a mix of direct instruction (Larson & Littell, 2005) and multimedia offerings from Khan Academy (Khan, 2011) and Pearson's Virtual Nerd ("Pre-Algebra," 2008) websites.

The formative assessments came from the textbook, the computer-based A+nywhere Learning System and items I combined from all of the listed sources. I provided printed pages that would serve as guided notes. I permitted these notes to be used as reference material when the projects began.

To create a meaningful dialog about the content, I implemented Project-Based Learning as a way to engage the students, and provide a way for them to index and develop their learning. I used a series of projects that assessed the skills from the presentations.

To facilitate this achievement, learning included three of the five conditions (Driscoll & Driscoll, 2005, pp. 393 - 394) for constructivist learning:

1. Embed learning in complex, realistic and relevant environments.
 - a. Examples from the local community will be incorporated in the learning through the use of two hands-on projects that will challenge the students to explore how pre-algebra mathematics is used in their lives to make decisions and guide them to better choices for them.
 - b. The projects were obtained from two sources

- i. Project-based pre-algebra curriculum (Moore, 2010) was obtained from Curriki.com
 - ii. The class' final project, "Combating Poverty & Microloans -- International Proportion & Percent Project" (*Combating Poverty & Microloans -- International Proportion & Percent Project.*, 2012) was obtained from TeachersPayTeachers.com cooperative.
- 2. Support multiple perspectives and the use of multiple modes of representation.
 - a. Encourage the group projects to use technology as they choose, within the time constraints. Reports may include a simple verbal report, or other methods of delivery, such as a video, or Prezi presentation.
 - i. Scientific calculators and laptop computers were provided to help students access the necessary materials and programs to design and complete their projects.
 - ii. Projects ranged from posters and hand drawn fliers to PowerPoint and Prezi outputs. Access to appropriate and necessary web resources were made available to the students.
 - b. Provide class discourse so all students may participate in the learning process through direct questioning and shared responses as appropriate.
 - i. Students initially were required to participate in groups designated by the teacher. This was intended to break down conversational barriers between students who were unfamiliar with each other and how to work in a collaborative setting.

- ii. The work was designed to facilitate group cooperation. The amount of time for each project was less than a reasonable amount for one person to complete the project alone.
 - iii. After three assigned collaborative efforts, students were permitted to choose their own groupings or to work alone. The workload was not modified for single students. If they chose to work alone, then they understood they were at a disadvantage compared to a collaborative group.
 - iv. Groups were asked to present their results in a public manner. This reporting took place as a stand-up presentation, demonstrating the solutions on the board, or providing handouts for the others to review. It was unnecessary to provide special assistance to the special education students because they all opted to work with at least one partner.
3. Nurture self-awareness of the knowledge construction process.
- a. All students will construct and maintain a daily journal answering the following two questions daily:
 - i. What surprised me?
 - ii. What confused me and what are the questions that I need answered?

Results

Assessment Outcomes

The class, which began with 32 students at the start of the term, concluded with only 17 students finishing the course. This drop in attendance was fairly consistent with past experience in the West Phoenix area. Five students, including one special education student, were removed from school because of behavioral issues. Three students were detained by juvenile probation. The remaining six students who did not complete the course were dropped for lack of attendance. The school leadership is still attempting to discover the underlying cause or causes for the dropout group.

The number of special education students experienced a proportional loss as well. Of the eight students who began the course, four were still in attendance at the end.

Class demographics reflect the community: no White students, three Black students, one biracial student, and 13 Hispanic students.

The academic assessment for the class was an adaptive assessment for Grade 8 mathematics from A +nywhere Learning System authored by AmerEd, Inc. of Oklahoma City. The materials are copyrighted by K12 Management, Inc. and copyright permission to include the actual test questions was not obtained. I used the same test as a pre- and post- measurement. This assessment was only administered twice: week 1 and week 6. Students and teachers are never shown the answers, so test validity remains intact.

Table 1

Academic pre- and post-assessment for pre-algebra students were administered 6 weeks apart. Algebra readiness cut off score is 30.

Student	Gender	Assessment 1	Assessment 2	Difference	Growth in 6 weeks
S1	F	16	26	10	+63%
S2	F	30	49	19	+63%
S3	M	14	35	21	+150%
S4	F	17	22	5	+29%
S5	F	14	19	5	+36%
S6	M	27	35	8	+30%
S7	F	16	32	16	+5%
S8	M	28	35	7	+25%
S9	M	16	30	14	+47%
S10	M	25	41	16	+64%
S11	F	26	48	22	+85%
S12	M	29	51	22	+76%
S13	M	11	16	5	+45%
S14	F	19	47	28	+147%
S15	F	17	42	25	+147%
S16	F	11	9	-2	-18%
S17	F	17	29	11	+65%
Student Average		19.6	33.3	+13.9	+71%

Note: Student S16 missed 17 days of 30 possible class days. Student S17 was hospitalized for nine school days during this project. Students S9, S13 S14, and S17 are identified SLD students. 2 students passed without attaining the cutoff score due to modifications in the IEP. Students S2, S14 and S15 are expectant mothers. S4 and S15 are teen mothers. The growth rate was determined by dividing the difference value by the value of Assessment 1. Some assessments determine growth by measuring attained compared to potential. This assessment did not offer that type of measurement. This method was used because it is easily accessible and uses a reliable foundation of two comparable assessments. Neither the teachers or the students are able to view tested results. Teachers can view test items that are drawn from the assessment question bank.

The initial attitude survey (see Appendix A) asked 32 students to select one of five choices before they began the course. I was interested in a basic attitude survey about the students'

perceptions and bias toward or against math as a subject. Many of the students could pinpoint a specific teacher and grade where they began to not like math as an academic subject. Several of the students indicated they had not received much math help in grades 5 or 6. By the time they reached Grade 7, they were so far behind they believed they could no longer keep up with the work. The purpose was to examine what was causing the students to be less successful. I was also attempting to gauge where their deficiencies might be clustered. It was difficult for them to describe specifics.

I followed up with a series of group questions during class to gain more information. They were clear in when and what caused their answers. They did not understand how fractions and percent operated. There was evidence that multiplication skills were compromised at numbers above fives. In most cases, it involved a teacher telling them they were incapable of doing the work.

Table 2

Math attitude before the course began.

I hate math	I don't like math	Math is okay	I like math	I love math
6%	32%	44%	9%	3%

Note: The choice was then expanded in a written explanation. n = 32

The attitudes toward math were shaded toward the negative side of neutral. Many students expressed frustration with learning fractions and times tables. They said they would like to learn more, but teachers did not give them the support they needed. They questioned the relevancy of math in their lives. “When will I ever use this stuff?” was a common question for 22 students. Another comment was “It doesn’t make sense to me.” One student said, “This is the third time I am taking this class. Help!”

The exit survey, administered by Survey Monkey, asked the students about their views about the class, math and myself in general.

Table 3

Survey Monkey survey administered on Oct. 8, 2013 on the last day of class.

Question	Scale out of 5
Did the class projects help you understand math better than using the A+ computer course? 1- I prefer the computer; 5 – I prefer all projects	4.25
How much of your growth as a student (particularly a student of Math) would you attribute to Mr. Stodola? 1 – Not at all, 5 – A whole lot	3
How would you rate your average interest level in Mr. Stodola's pre-algebra class 1 – not interested; 5 – I could not miss a class!	3.75
How would you rate the level of difficulty of Mr. Stodola's class? 1- Easy; 5 – It feels like calculus might	3.4
How would you rate the value of in-class activities you do in Mr. Stodola's class towards your learning/education (i.e. projects, support materials)? 1- no value; 5 – extremely valuable	4.4
How would you rate the quality of instruction you have received in this class? 1 – poor; 5 - excellent	4.25
How much do you think you have learned in Mr. Stodola's class? 1 – Not much; 5 – A great amount	4.1
How you would rate the interest you have in Math as a subject? 1 – not interested at all; 5 – very interested	2.75
How would you rate yourself as a student in Mr. Stodola's Math class? 1 – poor; 5 - outstanding	3.75
How would you rate your GROWTH in Mr. Stodola's class from the beginning of the year to the end of the term? 1 – no growth; 5 – I learned a whole lot	3.4

Note: n=16

This survey indicates students preferred using a hands-on approach when compared to an on-line format. The question about the in-class projects and handouts received the highest rating by the students. It appears that there may have been some shift in student attitudes about math as a subject, but it appears insignificant.

The projects kept the interest higher than only direct instruction and computer-based assessments. The responses also indicate that I held the students' interest in the subject as the class progressed. Upon reflection, a competent teacher with engaging materials can make a difference in student progress.

Student Achievement

The second set of outcomes utilized were the student grades for the course. Forty-six percent of the students (11 out of 24 students) who finished the final pre-algebra course in the

previous term received passing grades. I compared the school data for the two classes and found the demographics to be similar. There were no repeating students between the classes, which I found unusual. The reason for comparing the two classes was to explore the impact of adding projects to the course of study and reducing the items being taught might cause student outcomes to change.

By utilizing the rubrics provided for the projects and the formative assessments used in conjunction with the scaffold lesson material, 14 of the 17 students of my pre-algebra course received passing grades. This equates to a passing rate of 82% of the students eligible for a grade to be issued.

Projects and Activities

At first, the students were resistant to the change in focus of the class. They expressed a desire to work on the A+LS program, but were not prepared for the demand of the higher-order skills needed to complete the projects. The first set of projects combined Cartesian coordinates with connect-the-dots artwork (see Appendix B). They did very well with the projects. As we migrated through the four separate iterations, the students not only completed the coordinate geometry in much less time, they also began paying attention to the aesthetics of their products.

At the beginning, the students struggled with completing the wire-framed outlines. It took them a great amount of time (more than 30 minutes) at the beginning. Much of this time was spent locating the coordinates on the grid. They came to me multiple times for clarification of the coordinate pairs. Some students plotted all the points and then were unable to connect the dots because they did not connect the points as they went along with the construction. On the second iteration, they completed more complex wire forms in less time. Before they took more than 30 minutes to construct forms with approximately 30 coordinates, now they created multiple forms

totaling more than 120 ordered pairs in about 30 minutes. They also began to color their artwork. And, by the fourth project, they were creating actual art as opposed to the wireframes of earlier iterations.

The next step was for the students to create a coordinate listing for a wireframe drawing (see Appendix C). They had to incorporate all four regions of the coordinate plane and include a completed picture to finish the project. Many of them determined it was easier to create the frames first, and record the coordinates next.

After working with the coordinate geometry, the students moved into number theory and number manipulation (see Appendix D). They were assigned a project to manipulate four instances of the number “4” to create 40 different outputs starting with an output value of 1 and continuing to an output value of 40. The time constraint imposed forced them to work in quartets to cut the individual cognitive load. I assigned students to groups based upon their beginning assessment scores. I inserted at least one higher scoring student in each group. I also spread the special education students throughout the groups so they were forced to interact with mainstream students. Using heterogeneous groupings promoted differentiation within the groups. They had to select a group leader and a group secretary. This arrangement also taught them the value of cooperation and collaboration. Many of the groups did not complete the entire outcome chart, but three out of the six groups correctly completed more than 30 examples. These groups were kept together for the first main project. As students withdrew from the classroom and school, the number of groups dropped from six to three. Existing groups were consolidated instead of being redistributed. At the time of the second and final main project, I let the students decide if they wanted to shift group memberships. They chose to reform groups and proceeded on to the final project. This decision to release control to the students seemed to be beneficial. They were able

to form new associations and regroup along academic lines more noticeably than at the start of the term.

The students were simultaneously introduced to addition and subtraction properties of fractions and number line theory. The first hour of the block was spent on fractions, and the second hour focused on signed numbers and how to maneuver on the number line for adding signed numbers. These two related topics took twice the time I expected. Instead of spending eight hours total on the topics of addition and subtraction properties, it took almost 15 hours of instruction before the students began to show some understanding of how to handle the addition and subtraction of fractions. At one point, the students were assigned computational work during the class. They completed more than 125 fraction computations in less than 90 minutes. A couple of the special education students who were struggling with the concepts were given additional time and help with the special education teacher in a pullout room. The overall output showed the average work had more than 75% correct.

The students then moved into rational numbers and proportion properties. At this point, I introduced fraction multiplication and division properties in multiple formats, including quadratics, linear, and cubic equations to expand their horizons on what academic math resembled. They did not work the quadratics or cubic problems, but I wanted them to see the similarities between what they were learning and how these concepts and tools worked with more advanced mathematical equations.

First major project

At this time, I introduced the first major project to the students. The purpose was to incorporate their newly learned fraction tools along with calculating percentage and use these tools to aid in predicting outcomes. The project was obtained from Curriki (Moore, 2010) and

involved counting M&M candies by their colors (see Appendix E). The students were assigned to create a statistical profile of the bag of candy. Part of the experience informed them that the bags were uniform in weight. They also determined differentiation is done by the color of the coating on the candy. These were tallied and compared to the findings of each group. At the end of this project, the student groups made predictions about the contents of unopened bags, and then compared the actual contents to their predictions.

A second run of the project was made using a different candy, “Dots”. The most significant observation was the time it took to run the second experiment when compared to the first one. While the first run with the M&M’s took the students more than two hours to complete, the second run using the Dots was completed in 30 minutes. At the conclusion of this project, we moved on to the final project of the term.

Second major project

The project material for the final was obtained from 21st Century Math Products via the TeachersPayTeachers.com website. The project, titled “Combating Poverty & Microloans -- International Proportion & Percent Project”, combined all of the skills and content topics the class was studying (see Appendix F). There were four parts to the project.

First, the students had to convert various numbers about aspects of the global population into percent. Then they made observations about the data they had created. The second step was to explore and understand the economic concept of Fair Trade. To accomplish this, the students were shown two videos about Fair Trade (Foundation, 2012, 2013a, 2013b).

At the end of the presentation, the students then were assigned to compare the Fair Trade pricing to the non-Fair Trade pricing examples from around the world. After making the

comparisons, the students then had to generate answers to questions that showed the economic impact of supporting Fair Trade economics in everyday goods.

The third component of the final project was for the students to explore the impact and efficacy of micro-loans on poverty. Students were shown videos about micro lending (Kiva, 2012, 2013; kivavideos, 2010) and how these financial vehicles help reduce poverty through self-reliance. Once the videos were completed, the students were then given loan applications for four fictitious borrowers. The students needed to “process” two of the four applicants and answer the questions that accompanied the lending document.

This activity led to the fourth and final piece. The students were assigned to find a deserving loan candidate at Kiva.org (Kiva, 2013). The students were given the flexibility to work alone, or in a group of no more than three individuals. Students would then make a public presentation and appeal for their prospective borrower to be awarded the funds.

I procured \$25 from the school’s activity fund to use as seed money for the culminating activity. Another teacher also contributed \$25, which brought the funding amount to \$50. After the presentations, the students would decide in a democratic vote which loan would be awarded the funds. One presentation was a student making an impassioned pitch while holding a science fair poster depicting his borrower’s photo and key facts about him. Two other groups designed and delivered a Prezi presentation on the room’s VGA projector. Another group presented a short PowerPoint presentation complete with photos of the borrower and the borrower’s family.

All of the presenters had to answer questions posed by the audience that helped determine the most deserving candidate. This project consumed ten hours of class time. It became apparent a majority of the students were deeply engaged with the materials. The presentations allowed them to rewrite their information and present it to the class. The students discovered they needed

a lot of work and time to make a complete presentation. There were two groups of students who did not put much effort into their presentations that resulted in degraded performance. At the end, the students were asked to reflect on how the math helped them make their case for the borrower each group chose. They were able to make the connection that the math helped them understand the activity deeper and prepare a better cost-benefit analysis for the audience to consider.

In one presentation, the borrower had made arrangements with a local company to exchange carbon credits for retiring the loan. Although we did not explore carbon credits, the students reached into their fund of knowledge from other classes to explain the economics of the transactions. The cross-curricular content did surprise them. One student commented he learned about cap and trade in his science class the previous year. He was surprised that the science and economic content showed up in his math class. Many students were surprised how their knowledge from other academic areas kept appearing in the math project. These results demonstrated the benefits of spending the time on the project.

Reflection results

The students were asked to complete a reflection every day at the end of class. Many of the students attempted this, but found the written reflections to be difficult to complete. I modified this activity to an oral discussion and had the students form pairs to reflect on the things they learned and what surprised them. Although this activity was difficult for them to perform, there were some insightful remarks that were consistently appearing when the students made the effort. After the more challenging project components, students commented that the work was easier than they had anticipated. Another theme that was repeated was the idea that the projects were not what they expected of mathematics assignments. Initially, students had found

it difficult to connect the mathematics to life's activities and they have found more relevance for math in their lives.

My students seem to disconnect their academics from their lives. School is something to do, not provide something to learn. There seems to be the expectation that they are acting as if they are checking off tasks on a list. There have been many students who ask why they are placed in remedial class when they already "passed Algebra and Geometry." As a group, they did not understand that school is for learning concepts, not only checking off activities that have been completed.

As we began to proceed through the scaffolding and the projects, the students initially needed two hours to complete each of the (?) activities. They were unprepared to meet the cognitive demand of the questions. In at least two conversations, I was begged to hand out a worksheet instead of open-ended questions. I interpreted this as resistance to higher cognitive demands. I persisted in having them work on a second iteration. The second time the students performed the data and prediction activity, they finished the work in less than 30 minutes.

When the students reflected on their experience, they stated they were able to complete the tasks in less time because they, "knew what to do and what to look for." It was during this set of activities the students began to look forward to the projects. I took an informal survey and all but two students preferred working projects instead of worksheets.

This pattern continued into the Combating Poverty activities. The resistance to engage had disappeared, and the students changed the way they asked questions. Instead of being confused, they looked for ways to work the activities without my assistance.

Technology was always readily available for their use. I encouraged them to use their cell phones' calculators to work the math. They also had scientific calculators and netbooks with Wi-

Fi support. These computers became valuable when they began to assemble their class presentations. I also required the students to use the computers to take the closing survey at Survey Monkey.

Discussion

It became apparent the students were unprepared by the diversity of the activities for a high school math class. They were very resistant at first. This was caused by the “new” requirement to be cognitively involved with the materials. Many of the students viewed math as “doing my work”, which turned out to mean working computations. The day I assigned computations was very enlightening. All of the students got right to work and completed a large number of computation exercises – over 100 items in less than two hours. The next day, I assigned four more computations for them to solve as a class warm up; they were unable to demonstrate retention until I worked an example on the board. They did not make the connection between the computations and skill sets.

Over the six weeks of class, the students gained awareness of math connections in their lives. The projects became more demanding, but the students found the material to be meaningful. This helped them make the necessary connections between the academics and the practical.

Most of the students did not take adequate notes. Many of them forgot their notebooks at home and had to copy days’ worth of notes from classmates. There is more work to be done in teaching the value of note taking to urban students. When they take notes, they do not understand the value of the notes they have been taking. It is another symptom of the disconnected nature

these students show. Their skill at taking notes did not improve much during the six weeks. In every group, however, there was at least one student who was adept at taking notes. This person served as a scribe for the overall group.

Another observation that I made pertained to student fear. I observed student uncertainty caused by lack of practice manifest itself in the reluctance of many students to risk making a mistake. Deming's eighth step for continuous improvement (Ayres, 2000, p. 145) is "drive out fear." The difficult part of teaching is to empower them to embrace mistakes as a natural part of learning.

The plan was to keep my math activities strictly in the STEM domains. The data collection and prediction activities using the candy were in the general theme I planned to consistently use throughout the class. I never intended to take the class in a direction of social justice as found in the poverty project material. My intent was to use engaging, every day activities, such as food recipes, trip planning and grocery shopping. As I looked for materials that would engage the students, I happened across the poverty and micro-lending materials selected for the final project. The project dealt with all the topics the students had been studying, and it was a good fit for the class.. The students were unable to choose between the two final candidates, so they decided to split the \$50 award into two \$25 awards.

At the end of the project, there were some significant lessons I learned about myself as an educator. First, I no longer embrace only mastery-based learning. I have become an educator who also embraces project-based and problem-based learning. The learning landscape has to include more than rote facts and figures for our underserved populations to perform to higher expectations. I found that the inclusion of constructivist learning theory has a valuable place in

the urban school environment. Students learn in more ways when they have to participate in creating their own knowledge funds.

Using projects has increased the number of students who earned credit and demonstrated high school algebra readiness. Student participation and voice is a critical part of keeping learning relevant.

As the country continues to pursue better educational policies and practices, freshened learning and relevancy have to be a priority. Engaging our most underserved and highest need students in learning demands that curriculum must appeal to the students and be taught by innovative educators in innovative ways.

The drive for academic standards should give rise to using alternative learning theories and strategies. In the same way we expect students to apply learning in new and different scenarios, educators must apply these same expectations to themselves. If pedagogy and strategies do not work successfully, then the educator must have the knowledge and flexibility to approach the situation differently. In this research project, I added hands-on project material to the existing learning structure and observed positive results. These results did not expand the learning time or change the expectation for the students. Instead, it showed that adding a constructive practice and theory to the existing behaviorist environment provided the space for students to delve into deeper meaning and make the learning more meaningful in their lives.

The assessment tool that recorded the growth was an existing end-of-level assessment provided by the software provider. It was not something designed to specifically chart only what was added to the class itself. The assessment monitored all aspects of pre-algebra and reported on the developer's expected outcomes from the total course.

Good teachers using current, data-supported methods and practices can only help to turn the learning for these students back in a positive direction. If we are to better serve students in the 21st century, then using data to drive instruction becomes paramount to their success.

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Appendix A

(Ayres, 2000, p. 146)

Name _____

MATH ENTHUSIASM

Mark one choice.

I hate math.	
I don't like math.	
Math is okay.	
I like math.	
I love math.	

Write about your choice.

Appendix B
Geometry Grid Art
(Colli, 2012)

Level 1 Batman Symbol Name _____

Holding the paper horizontally, plot each point on the axes and connect them in order.

(0, -12)	(13, 7)	(-17, -9)
(4, -6)	(12, 5)	(-14, -11)
(5, -5)	(11, 4)	(-11, -12)
(6, -5)	(9, 3)	(-12, -11)
(7, -6)	(6, 3)	(-13, -9)
(8, -8)	(3, 4)	(-13, -8)
(9, -6)	(3, 12)	(-12, -6)
(10, -5)	(1, 9)	(-11, -5)
(11, -5)	(-1, 9)	(-10, -5)
(12, -6)	(-3, 12)	(-9, -6)
(13, -8)	(-3, 4)	(-8, -8)
(13, -9)	(-6, 3)	(-7, -6)
(12, -11)	(-9, 3)	(-6, -5)
(11, -12)	(-11, 4)	(-5, -5)
(14, -11)	(-12, 5)	(-4, -6)
(17, -9)	(-13, 7)	(0, -12)
(19, -7)	(-13, 8)	
(20, -5)	(-12, 10)	
(21, -2)	(-11, 11)	
(21, 1)	(-14, 10)	
(20, 4)	(-17, 8)	
(19, 6)	(-19, 6)	
(17, 8)	(-20, 4)	
(14, 10)	(-21, 1)	
(11, 11)	(-21, -2)	
(12, 10)	(-20, -5)	
(13, 8)	(-19, -7)	

Level 1 Yankees Symbol Name_____

Holding the paper vertically, plot each point on the axes and connect them in order.

(4, -15)	(4, 10)	(-2, -12)
(3, -14)	(2, 4)	(-3, -14)
(2, -12)	(1, 2)	(-4, -15)
(2, -5)	(0, 1)	(4, -15)
(4, -6)	(-1, 2)	
(6, -8)	(-2, 4)	
(8, -12)	(-4, 10)	
(8, -15)	(-4, 13)	
(13, -10)	(-9, 9)	
(11, -9)	(-7, 8)	
(10, -6)	(-6, 7)	
(9, -1)	(-3, 1)	
(9, 0)	(-7, 4)	
(10, 3)	(-9, 7)	
(12, 6)	(-10, 8)	
(9, 8)	(-13, 5)	
(7, 5)	(-11, 2)	
(6, 2)	(-10, -1)	
(6, -1)	(-10, -6)	
(7, -6)	(-11, -9)	
(2, -2)	(-13, -11)	
(4, 2)	(-8, -15)	
(5, 5)	(-8, -9)	
(6, 7)	(-7, -5)	
(7, 8)	(-7, -2)	
(9, 9)	(-8, 2)	
(4, 13)	(-2, -3)	

Level 2	Snoopy	Name _____
Holding the paper vertically, plot each point on the axes and connect them in order. Do not connect the shapes to each other.		
Shape 1	(-9, -20)	(-5, 9)
(-10, -17)	(-8, -17)	(0, 9)
(-10, -9)	(-8, -20)	(1, 8)
(-13, -9)	(-7, -18)	(2, 8)
(-14, -8)	(-7, -20)	(3, 9)
(-14, -6)	(-6, -18)	(7, 9)
(-13, 0)	(-6, -20)	
(-12, 5)	(-5, -17)	Shape 4
(-11, 9)	(-5, -20)	(-8, 12)
(-9, 9)	(-4, -18)	(-8, 13)
(-10, 10)	(-4, -20)	(-7, 13)
(-10, 11)	(-3, -18)	(-7, 12)
(-9, 13)	(-3, -20)	(-8, 12)
(-9, 15)	(-2, -17)	
(-8, 17)	(-2, -20)	Shape 5
(-6, 19)	(-1, -18)	(-2, 9)
(-6, 20)	(-1, -20)	(-2, 13)
(-5, 20)	(0, -18)	
(-5, 19)	(0, -20)	Shape 6
(-3, 17)	(1, -17)	(-1, 9)
(-2, 13)	(1, -20)	(-1, 13)
(-1, 13)	(2, -18)	
(0, 14)	(2, -20)	Shape 7
(2, 14)	(3, -18)	(2, 8)
(4, 12)	(3, -20)	(2, 9)
(5, 12)	(4, -17)	
(4, 13)	(4, -20)	Shape 8
(4, 15)	(5, -18)	(3, 9)
(5, 16)	(5, -20)	(3, 10)
(6, 16)	(6, -18)	(2, 11)
(7, 15)	(6, -20)	(0, 11)
(7, 9)	(7, -17)	
(8, 9)		Shape 9
(9, 5)		(7, 14)
(10, 0)	Shape 2	(6, 14)
(11, -6)	(-6, 19)	
(11, -8)	(-5, 19)	
(10, -9)		Shape 10
(7, -9)		(7, 15)
(7, -20)	Shape 3	(6, 15)
(8, -18)	(-9, 9)	
(8, -20)	(-6, 9)	
(-11, -20)	(-7, 6)	Shape 11
(-10, -17)	(-7, 3)	(-11, 4)
(-10, -20)	(-6, 2)	(-7, 4)
(-9, -18)	(-5, 2)	
	(-4, 3)	
	(-4, 6)	

Level 2 Mickey Mouse Name _____

Holding the paper vertically, plot each point on the axes and connect them in order. Do not connect the shapes to each other.

Shape 1

(-5, -4)

(-4, -6)

(-3, -7)

(-1, -8)

(0, -9)

(1, -11)

(2, -11)

(4, -10)

(5, -9)

(7, -9)

(11, -7)

(12, -6)

(13, -4)

(14, -2)

(14, 0)

(13, 1)

(12, 1)

(11, -1)

(10, -1)

(11, 1)

(11, 2)

(9, 6)

(7, 8)

(4, 9)

(5, 10)

(6, 12)

(6, 13)

(5, 15)

(4, 16)

(2, 17)

(0, 17)

(-2, 16)

(-3, 15)

(-4, 13)

(-4, 11)

(-3, 9)

(-2, 8)

(-3, 7)

(-4, 5)

(-5, 7)

(-6, 8)

(-8, 9)

(-10, 9)

(-12, 8)

(-13, 7)

(-14, 5)

(-14, 3)

(-13, 1)

(-12, 0)

(-10, -1)

(-8, -1)

(-6, 0)

(-6, -1)

(-5, -4)

(-5, -1)

(-4, 0)

(-2, 1)

(-1, 1)

(1, 0)

(2, -1)

(2, 0)

(1, 3)

(1, 4)

(2, 7)

(4, 8)

(6, 8)

(7, 6)

(8, 7)

Shape 2

(6, -9)

(4, -8)

(2, -9)

(1, -9)

(0, -5)

(0, -4)

(4, -8)

(2, -7)

(0, -4)

(-1, -2)

(-2, -3)

Shape 3

(-1, -2)

(0, -2)

Shape 4

(6, -2)

(7, 0)

(7, 3)

(6, 4)

(5, 4)

(4, 3)

(4, 0)

(5, -2)

(6, -2)

(6, 0)

(5, 1)

(4, 0)

Shape 5

(3, 4)

(3, 5)

(4, 6)

Shape 6

(8, 1)

(9, 0)

(9, -2)

(8, -1)

(8, 2)

(9, 3)

(10, 2)

(10, -1)

(7, -4)

Shape 7

(7, -3)

(9, -2)

Shape 8

(8, 4)

(9, 4)

(10, 3)

Shape 9

(13, -4)

(12, -4)

(11, -3)

(11, -1)

Level 4 Betty Boop Name _____
 Holding the paper horizontally, plot each point on the axes and connect them in order.
 Do not connect the shapes to each other.

Shape 1	Shape 2	(-6, -11)	(-4, 1)	Shape 17
(-9, 4)	(12, 7)	(-8, -10)		(4, 2)
(-9, 6)	(11, 4)	(-8, -8)	Shape 8	(5, 3)
(-10, 7)	(9, 1)	(-6, -6)	(-7, 3)	
(-9, 7)	(7, -2)	(-7, -4)	(-8, 4)	Shape 18
(-10, 8)	(6, -3)	(-9, -1)		(5, 4)
(-9, 10)	(6, 0)	(-10, -1)	Shape 9	(2, 7)
(-10, 11)	(5, 2)	(-10, 0)	(-6, 4)	
(-9, 12)	(6, 1)	(-9, 1)	(-6, 5)	Shape 19
(-9, 11)	(7, 1)			(-18, 14)
(-8, 11)	(8, 3)	Shape 3	Shape 10	(-17, 13)
(-8, 12)	(8, 4)	(-9, -1)	(-5, 4)	(-14, 13)
(-7, 14)	(7, 4)	(-8, -1)	(-5, 5)	
(-6, 14)	(7, 5)	(-6, -2)		Shape 20
(-5, 15)	(8, 5)	(-3, -3)	Shape 11	(17, 13)
(-4, 15)	(8, 7)	(-2, -4)	(-4, 3)	(19, 13)
(-5, 14)	(6, 7)	(-1, -3)	(-3, 4)	
(-3, 15)	(5, 8)	(0, -3)		Shape 21
(-1, 15)	(6, 8)	(3, -4)	Shape 12	(17, 12)
(1, 14)	(4, 9)	(4, -4)	(-7, 5)	(19, 12)
(0, 13)	(4, 8)	(6, -3)	(-5, 8)	(21, 13)
(-2, 10)	(2, 8)	(5, -4)		
(-2, 9)	(2, 9)		Shape 13	Shape 22
(-4, 10)	(3, 10)	Shape 4	(3, 3)	(2, -13)
(-5, 10)	(-1, 9)	(-3, -3)	(3, 2)	(0, -11)
(-5, 9)	(-1, 10)	(-2, -2)	(4, 2)	(1, -10)
(-6, 9)	(1, 13)	(-1, -3)	(3, 3)	(1, -9)
(-6, 10)	(3, 14)		(2, 3)	(0, -7)
(-8, 9)	(5, 14)	Shape 5	(1, 2)	(-1, -7)
(-8, 6)	(7, 13)	(-8, 1)	(1, 0)	(-3, -8)
(-9, 4)	(8, 14)	(-8, -1)	(2, -1)	(-5, -6)
(-8, 1)	(8, 13)		(3, -1)	(-6, -6)
(-9, 1)	(11, 10)	Shape 6	(4, 0)	(-5, -4)
(-10, 2)	(12, 11)	(-3, 0)	(4, 2)	
(-13, 7)	(12, 10)	(-2, -1)	(3, 1)	Shape 23
(-14, 12)	(11, 9)		(4, 0)	(-3, -8)
(-17, 12)	(12, 7)	Shape 7		(-2, -7)
(-18, 13)	(15, 13)	(-5, 4)	Shape 14	
(-19, 13)	(19, 14)	(-5, 3)	(1, 2)	Shape 24
(-19, 14)	(19, 13)	(-4, 3)	(0, 3)	(6, -2)
(-15, 14)	(21, 13)	(-5, 4)		(7, -2)
(-17, 16)	(19, 11)	(-6, 4)	Shape 15	
(-16, 16)	(16, 11)	(-7, 3)	(2, 3)	
(-15, 15)	(14, 4)	(-7, 1)	(2, 4)	
(-14, 15)	(12, 0)	(-6, 0)		
(-12, 13)	(10, -3)	(-5, 0)	Shape 16	
(-10, 8)	(2, -13)	(-4, 1)	(3, 3)	
	(1, -15)	(-4, 3)	(3, 4)	
	(-6, -14)	(-5, 2)		

Level 2	Steelers Symbol	Name
Holding the paper horizontally, plot each point on the axes and connect them in order. Do not connect the shapes to each other.		
Shape 1	(-17, -2)	Shape 5
(2, 16)	(-17, 2)	(2, -15)
(7, 15)	(-16, 6)	(2, -14)
(12, 13)	(-14, 10)	(3, -11)
(15, 10)	(-12, 12)	(6, -8)
(17, 6)	(-7, 14)	(9, -7)
(18, 2)	(-2, 15)	(6, -6)
(18, -2)	(2, 15)	(3, -3)
(17, -6)		(2, 0)
(15, -10)	Shape 3	(1, -3)
(12, -13)	(17, 0)	(-2, -6)
(7, -15)	(16, 0)	(-5, -7)
(2, -16)	(13, 1)	(-2, -8)
(-2, -16)	(10, 4)	(1, -11)
(-7, -15)	(9, 7)	(2, -14)
(-12, -13)	(8, 4)	
(-15, -10)	(5, 1)	Shape 6
(-17, -6)	(2, 0)	(-15, 1)
(-18, -2)	(5, -1)	(-16, 1)
(-18, 2)	(8, -4)	(-16, 0)
(-17, 6)	(9, -7)	(-15, 0)
(-15, 10)	(10, -4)	(-15, -1)
(-12, 13)	(13, -1)	(-16, -1)
(-7, 15)	(16, 0)	
(-2, 16)		Shape 7
(2, 16)	Shape 4	(-14, 1)
	(2, 15)	(-12, 1)
Shape 2	(2, 14)	
(2, 15)	(3, 11)	Shape 8
(7, 14)	(6, 8)	(-13, 1)
(12, 12)	(9, 7)	(-13, -1)
(14, 10)	(6, 6)	
(16, 6)	(3, 3)	Shape 9
(17, 2)	(2, 0)	(-10, 1)
(17, -2)	(1, 3)	(-11, 1)
(16, -6)	(-2, 6)	(-11, -1)
(14, -10)	(-5, 7)	(-10, -1)
(12, -12)	(-2, 8)	
(7, -14)	(1, 11)	Shape 10
(2, -15)	(2, 14)	(-11, 0)
(-2, -15)		(-10, 0)
(-7, -14)		
(-12, -12)		
(-14, -10)		
(-16, -6)		
		Shape 11
		(-8, 1)
		(-9, 1)
		(-9, -1)
		(-8, -1)
		Shape 12
		(-9, 0)
		(-8, 0)
		Shape 13
		(-7, 1)
		(-7, -1)
		(-6, -1)
		Shape 14
		(-4, 1)
		(-5, 1)
		(-5, -1)
		(-4, -1)
		Shape 15
		(-4, 0)
		(-5, 0)
		Shape 16
		(-3, -1)
		(-3, 1)
		(-2, 1)
		(-2, 0)
		(-3, 0)
		(-2, -1)
		Shape 17
		(0, 1)
		(-1, 1)
		(-1, 0)
		(0, 0)
		(0, -1)
		(-1, -1)

Appendix C

Coordinate Art System Project
(Moore, 2010)Pre-Algebra
Due Date:_____Name:_____
Period:_____

Coordinate System Art

The Mathematical Challenge:

The object of this project is to create a work of art using ordered pairs. The requirements are as follows:

- ☐ At least 40 ordered pairs must be used in the design (at least 10 per quadrant).
- ☐ All four quadrants and the x and y-axes must be incorporated into the design.
- ☐ At least four equations must be incorporated into the design. A minimum of 5 ordered pairs must be used per equation. You may use:
 - Horizontal lines: ex. $y = 4$
 - Vertical lines: ex. $x = -4$
- ☐ Record your ordered pairs and equations in the table provided. Your instructor will match these ordered pairs to your graph. The poster will also be assessed for creativity and neatness.
- ☐ Make sure to use the rubric provided as a guideline for success.

The Artistic Component:

Brainstorm a creative design that would incorporate the parameters stated above. Use the graph paper, markers, and rulers provided and make sure the ordered pairs and lines are clearly marked in your design.

Record the ordered pairs for the four quadrants below:

Quadrant 1	Quadrant 2	Quadrant 3	Quadrant 4
Ordered Pairs	Ordered Pairs	Ordered Pairs	Ordered Pairs
x y	x y	x y	x y

Record the ordered pairs for the actual equations below:

Equation 1	Equation 2	Equation 3	Equation 4
_____	_____	_____	_____
Ordered Pairs	Ordered Pairs	Ordered Pairs	Ordered Pairs
x y	x y	x y	x y

Grading Rubric: Your grade will be determined by the following point scheme:

	Ordered Pairs	Quadrants	Equations	Axes	Neatness	Creativity
4 Points	38-40 correct	4 quadrants used in design & labeled properly	4 equations graphed and labeled correctly	Entire x and y axes utilized in design	Project is neat, organized and aesthetically pleasing	Highly creative and original design
3 Points	35-37 correct	3 quadrants used in design & labeled properly	3 equations graphed and labeled correctly	Partial use of x and y axes in design	Partially lacking in organization, neatness and/or aesthetics	Partially lacking creativity or originality
2 Points	30-36 correct	2 quadrants used in design & not all labeled properly	2 equations graphed and labeled correctly	Use of only one axis in design	Mostly lacking in organization, neatness and/or aesthetics	Partially lacking creativity and originality
1 Point	Below 30 correct	1 quadrant used in design & not labeled properly	1 equation graphed and labeled correctly	x and y axes were not used in the design	Messy and unpleasing to the eye	Totally lacking creativity and originality

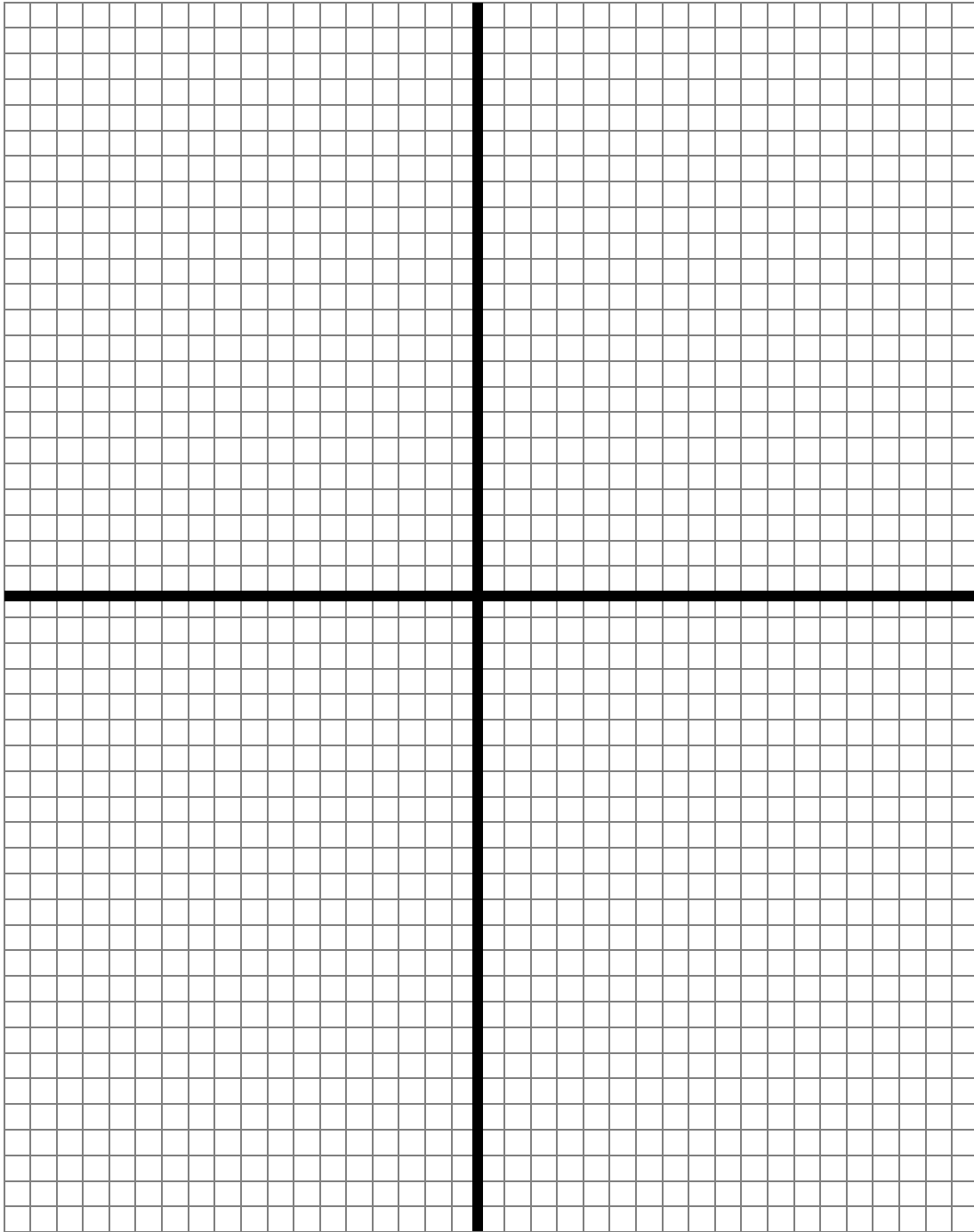
Self-Assessment:

Please self score your project based on the rubric above. Record you scores in the space

provided below. Failing to complete the self-assessment will result in a 2-point reduction in the project's overall grade.

	Ordered Pairs	Quadrants	Equations	Axes	Neatness	Creativity	Total Score
Self Score (1-4)							24

Matching the instructor's grade will add an additional 1 point to your overall grade. Over scoring yourself by 4 points will reduce your point total by one, so score yourself accurately!!!



(Moore, 2010)

Appendix D
Four-Fours Lesson Plan
(Moore, 2010)

Introduction: The Four Fours project is a collaborative activity that stresses problem solving and critical thinking as applied to order of operations problems.

Timing: This activity requires 90-120 minutes of class time to complete. Break it up over two, maybe three periods. Some of the project can be assigned for homework. Getting the math component done in class will allow students to focus on the creative component at home and will reduce the chance that students will get too far off base with the mathematical side of the project.

Group Size: Groups of 3 or 4

Learning Objectives: The objective of this activity is to:

- a) Review order of operations
- b) Develop problem solving and critical thinking skills
- c) Integrate a creative component into a traditional math lesson

Guiding Question: How can you use order of operations to manipulate four fours to produce a desired result?

Materials: The provided graph paper, markers, colored pencils, and other random art supplies. Photocopy enough activity sheets for each student.

Procedures:

Read through the opening sections as a class. Students should feel comfortable with the example calculation and understand that the grouping symbol (addition within the parenthesis) must be completed first, followed by the multiplication, and finally by the addition. Cover the advanced operations and leave the solved values on the board. Once students feel comfortable with the mathematical side of the project, have them split up their number and get started. Student will inadvertently discover other group

member's numbers. It can be really tough to get all 40, so I usually let it slide. Many students will need continued support. It can be tricky when they get down to their last couple.

Focus on the art component the following day. I typically won't give out the art supplies until they are 3/4th of their numbers done and an initial outline of their poster. Students can present their four fours in a variety of ways. I have had posters range from The Four Four's Matrix, with the number streaming like the opening of the movie, to pop-out fish with the four fours written on each fish. Try and keep the poster size standard if you want to post them around the room after completion. The years where it wasn't standardized, I received enormous projects along with mini ones.

Students must record their four fours on the table provided. This is where their four fours will actually be graded for correctness. The poster will only be assessed for creativity and neatness.

Make sure students understand the use of the rubric and know that they must score themselves before the project is turned in. The extra point is given with the idea that if anyone matches my score, they must have used the rubric properly. The same goes for taking the point. If they over-scored themselves by four points, they probably did not follow the rubric.

The group grader can be used if students feel like that one or two members did not participate fully.

If there is available time, I typically allow groups to present their posters to the class.

Groups should only turn in one of their activity sheets with the actual project.

Assessment: Each group's four fours should be graded based on the rubric included in the activity sheet. I score to the half point with the rubric.

Answer Key: Each group's four fours will be different, so an answer key would be of no use.

Four-Fours Project material

Order of Operations

Due Date: _____

Group Members: _____

Period: _____

Four Fours Project**The Mathematical Challenge:**

The objective of this group activity is to use your knowledge of order of operations and a combination of four fours to create all the numbers from 1 to 40 (1 to 30 if you are in a group of 3). The four fours must be mathematically manipulated to create your desired number. For example, we can use four fours, grouping symbols, and three operations to create the number 8.

Ex. $(4 + 4) + 4 \times 4 = 24$

The requirements are as follows:

- ❑ You must use exactly four fours each time to create the numbers 1 through 40 if you are in a group of four, or 1 through 30 if you are in a group of three.
- ❑ You may choose any or the main operations: +, -, ×, ÷. You must have an equal distribution of these operations throughout all of your four fours.
- ❑ The number four may also be manipulated by using one of the following advanced mathematical operations: $4!$, 4^2 , 4^3 , 4^0 , and $\sqrt{4}$. You must use at least 20 advanced operations (15 if you are in a group of 3) throughout your four fours.
- ❑ Your group may complete an additional 10 four fours for extra credit. Groups of 4 will do 41-50 and groups of three will do 31-40.

- ❑ Split the numbers equally between group members. Each person should be responsible for completing ten four fours. If a group member finishes theirs early, they may assist a group member or start on the extra credit.
- ❑ Record your four fours in the table provided. This is where the instructor will actually grade your group's project for correctness. The poster will only be assessed for creativity and neatness.
- ❑ Make sure to use the rubric provided as a guideline for success.

The Artistic Component:

Brainstorm a creative way of presenting your four fours in poster format. Use the colored poster paper, construction paper, markers, scissors, and other supplies provided to create a neat finished product. The poster size is fixed, but creative ideas for presenting the poster to the class will be considered.

Record your four fours with their corresponding value below:

Hint: Keep track of your operations and grouping symbols as you go.

Number	Four Fours	Number	Four Fours
<i>Example.</i> 18	$4^2 - 4 \cdot \sqrt{4} + 4 = 18$		
1		21	
2		22	
3		23	
4		24	
5		25	
6		26	
7		27	
8		28	
9		29	
10		30	
11		31	
12		32	
13		33	
14		34	
15		35	

16		36	
17		37	
18		38	
19		39	
20		40	

Grading Rubric: Your grade will be determined by the following point scheme:

	Accuracy	Operations	Advanced Operations	Grouping Symbols	Neatness	Creativity
4 Points	38-40/ 28-30 correct	All operations were used equally and correctly	At least 20/15 advanced operations were used correctly	Grouping symbols were used for at least half the time	Project is neat, organized and aesthetically pleasing	Highly creative and original design
3 Points	35-37/ 25-27 correct	Most operations were used equally and correctly	At least 15/11 advanced operations were used correctly	Grouping symbols were used for almost half the time	Partially lacking in organization, neatness or aesthetics	Partially lacking creativity or originality
2 Points	32-34/ 22-24 correct	Some operations were not used equally and/or correctly	At least 10/7 advanced operations were used correctly	Grouping symbols were used some of the time	Mostly lacking in organization, neatness or aesthetics	Partially lacking creativity and originality
1 Point	28-21/ 18-21 correct	Many operations were not used equally and/or correctly	At least 5/3 advanced operations were used correctly	Grouping symbols were rarely used.	Messy and unpleasing to the eye	Totally lacking creativity and originality

Note: All gray text are values for groups of three.

Self-Assessment:

As a group, please self score your project based on the rubric above. Record you scores in the space provided below. Failing to complete the self-assessment will result in a 2-point reduction in the project's overall grade.

	Accuracy	Operations	Advanced Operations	Grouping Symbols	Neatness	Creativity	Total Score
Self Score (1-4)							<div></div> <div>24</div>

Matching the instructor’s grade will add an additional 1 point to your overall grade. Over scoring yourself by 4 points will reduce your point total by one, so score yourself accurately!!!



Appendix E

(Smith & Stanley, 2004)

M&M Counting Sheet

12						
11						
10						
9						
8						
7						
6						
5						
4						
3						
2						
1						
	Red	Blue	Brown	Green	Orange	Yellow

(Smith & Stanley, 2004)

M&M Graphing and Probability

(Smith & Stanley, 2004)

An AskERIC Lesson Plan

AUTHOR: Karen Stewart, Harmony Elementary, Cushing,

OK Date: 1994

Grade Level(s): 1, 2, 3, 4, 5

SUBJECT: Mathematics/Probability

OVERVIEW:

Charts and graphs are not only valuable instruments for communicating data quickly and simply, they can be tools for stimulating discussion, and aids in promoting mathematical thinking.

Graphing activities for elementary students should include more than fixed displays of information. A hands-on, relevant lesson can be a successful way of teaching concepts which students are more likely to retain. M&M Graphing And Probability can be as simple as making a pictograph (1st and 2nd grades), or as involved as predicting and determining probability (3rd- 5th grades).

PURPOSE:

To provide students with a hands-on and cooperative learning experience in the process of collecting, analyzing, and interpreting data, and to improve decision making skills through the use of probability.

OBJECTIVES:

Students will be able to:

1. Count, sort, and classify M&M's by color.
2. Record data on a chart.

3. Use data from a chart to create a pictograph.
4. Use data from a chart to create a bar graph.
5. Use data from a chart to create a circle graph.
6. Analyze and interpret data.
7. Use data to figure ratios.
8. Use data to determine probability.

Curriculum

- ☐ Mathematics/Problem Solving and Reasoning/General Problem Solving and Reasoning
- ☐ Mathematics/Problem Solving and Reasoning/Understanding Problems
- ☐ Mathematics/Problem Solving and Reasoning/Logical Reasoning
- ☐ Mathematics/Problem Solving and Reasoning/Generalize
- ☐ Mathematics/Whole Numbers and Numeration/Number Properties/Fractions Decimals

Ratio

Percent

- ☐ Mathematics/Statistics and Probability/Statistics/General Statistics
- ☐ Mathematics/Statistics and Probability/Statistics/Data Collection-Organization
- ☐ Mathematics/Statistics and Probability/Statistics/Construct and Read Tables
- ☐ Mathematics/Statistics and Probability/Statistics/Construct and Interpret Graphs
- ☐ Mathematics/Statistics and Probability/Probability/General Probability

Process Skills

- ☐ Natural Science Process/Gather Data/Observe
- ☐ Natural Science Process/Gather Data/Measure
- ☐ Natural Science Process/Gather Data/Record

- ☐ Natural Science Process/Analysis Synthesis Evaluation/Infer
- ☐ Natural Science Process/Analysis Synthesis Evaluation/Investigate
- ☐ Natural Science Process/Analysis Synthesis Evaluation/Interpret
- ☐ Natural Science Process/Analysis Synthesis Evaluation/Hypothesize
- ☐ Natural Science Process/Analysis Synthesis Evaluation/Problem Solve and Conclusions
- ☐ Natural Science Process/Communicate Ideas/Define Ideas
- ☐ Natural Science Process/Communicate Ideas/Describe
- ☐ Natural Science Process/Communicate Ideas/Graphs Tables Maps
- ☐ Natural Science Process/Communicate Ideas/Oral and Written Expression

RESOURCES/MATERIALS:

- ☐ small bags of M&M's
- ☐ pencils
- ☐ paper
- ☐ rulers
- ☐ crayons or markers

ACTIVITIES AND PROCEDURES:

1. Give each student (or pair of students) one small bag of M&M's.
2. Ask students to open the bag, sort, and classify the M&M's according to color.
3. Ask students to record the information from step 2 on a chart.
4. After illustrating various pictographs, ask students to use their data to create their own pictograph.
5. Compare graphs. Have students discuss the differences and the similarities of the graphs.

6. Have class form small groups of 4-6. (possibly by rows in the classroom) Ask the groups to combine their data and make a new chart illustrating the results.
7. After discussing bar graphs, ask the groups to create and color a bar graph using the new figures. Compare this graph to the individual pictographs. Are the ratios the same.
8. Ask the groups to combining all of the data to include on a class chart. Round the numbers to the nearest tens for ease in creating a circle graph. You may want to do this together on the board or an overhead projector.
9. Ask students to determine the ratio of each color of M&M to the entire bag. With this information, the students can predict the probability of selecting one color at random from a large bag. How many of each color would be likely to be found in a handful of 10, of 20? Try it. Discuss the results. Then enjoy the M&M's.

TYING IT ALL TOGETHER:

Probability is an important decision-making tool. Teaching students to successfully use data from charts or graphs to predict probability will improve their decision-making skills. A hands-on approach will help students apply the concepts of graphing, and probability to other problem solving and risk-taking situations.

ADDITIONAL ACTIVITIES:

1. Get the students thinking in another direction. Ask them why they think the makers of M&M's make more brown ones than green. Write a creative essay about it.
2. Have students research to find out why there was a period of years that no red M&M's were made. When did they start including red M&M's in the packages again?

May 1994

These lesson plans are the result of the work of the teachers who have attended the Columbia Education Center's Summer Workshop. CEC is a consortium of teacher from 14 western states dedicated to improving the quality of education in the rural, western, United States, and particularly the quality of math and science Education. CEC uses Big Sky Telegraph as the hub of their telecommunications network that allows the participating teachers to stay in contact with their trainers and peers that they have met at the Workshops.

Appendix F

(Combating Poverty & Microloans -- International Proportion & Percent Project., 2012)




Project Title : Combating Poverty & Microloans
Standard Focus : Patterns, Functions & Algebra

Time Range : 3-4 Days

Supplies : Calculator

Topics of Focus :

- Proportions, Ratios & Percents
- Basic Operations
- Currency Conversion


Benchmarks :

Ratios and Proportional Relationships	6.RP	1. Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.
Ratios and Proportional Relationships	6.RP	3. Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.
Ratios and Proportional Relationships	6.RP	3c. Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means 30/100 times the quantity); solve problems involving finding the whole, given a part and the percent.
Ratios and Proportional Relationships	6.RP	3d. Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.
Ratios and Proportional Relationships	7.RP	2. Recognize and represent proportional relationships between quantities.
Ratios and Proportional Relationships	7.RP	2c. Represent proportional relationships by equations.
The Number System	7.NS	3. Solve real-world and mathematical problems involving the four operations with rational numbers.

Procedures:

A) Task 1: Provide students with “If the World Were a Village”. Afterward, have a class discussion of the most surprising findings. The results of this assignment will likely get students talking. Watching a “Shift Happens” YouTube video in conjecture with this lesson works well.

B) Task 2: Complete “Fair Trade”. As a warmup, have students look at the tags of their clothes. Where are the clothes from? If you have a map, you can map them. There are plenty of great Fair Trade videos on YouTube. You can watch a couple. Which works best will depend on the knowledge base of your students.

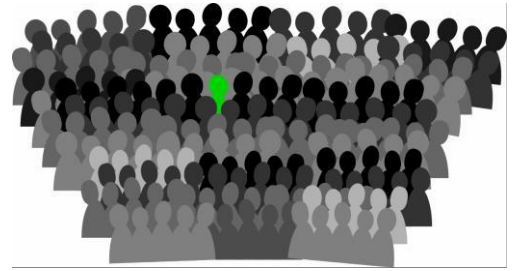
C) Task 3: Complete “Microlending”. Students can share answers in groups or as a class.

D) Optional: Task 4: Have students select an applicant off of Kiva.org and have them present them to the class using the mathematics similar in the activities.

E) Optional ***: Make a Microloan as a class ☺

IF THE WORLD WERE A VILLAGE OF 100 PEOPLE...

As the world's population grows, it's become apparent we are not alone. One look around a classroom can provide a snapshot of the population – but a woefully inaccurate one. Who are these other 6.9999 billion people? One way to look at this is through proportions. What if we shrunk our 7 billion people down to just 100? If the world were just one village, who would be in it?



To complete the following problem you will need to use the World's Current Population:
7,038,000,000

Gender

	Approx. Current Population	Proportion	if the world were 100 people... (round to nearest person)
Male	3,519,000,000		
Female			

Age

	Approx. Current Population	Proportion	if the world were 100 people...
Age 0-14			
Age 15-64	4,691,953,080		
Age 65+	563,040,000		

Dwelling

	Approx. Current Population	Proportion	if the world were 100 people...
Urban	3,589,380,000		
Rural			

Geography

	Approx. Fraction of Population	Proportion	if the world were 100 people...
Asia	$3/5$		
Africa	$3/20$		
Europe	$22/200$		
Latin America			
North America	$1/20$		

Religion

	Approx. Fraction of Population	Proportion	if the world were 100 people...
Christian			
Muslim	$11/50$		
Hindu	$7/50$		
Buddhist	$91/1,300$		
Other Religion	$3/25$		
No Religion	$120/1,000$		

First Language

	Approx. Ratio	Proportion	if the world were 100 people...
Chinese	Ratio of Chinese to the Population 3 : 25		
Spanish	Ratio of Chinese to Spanish 24 : 10		
English	Ratio of Spanish to English 1 : 1		
Arabic	Ratio of English to Arabic 10 : 6		
Hindi	Ratio of Arabic to Hindi 11 : 11		
Bengali	Ratio of Hindi to Bengali 400 : 400		
Portuguese	Ratio of Bengali to Portuguese 10 : 10		
Russian	Ratio of Portuguese to Russian 3 : 2		
Japanese	Ratio of Russian to Japanese x : x		
Other			

Literacy

	Approx. Ratio	Proportion	if the world were 100 people...
Can read and write	Ratio of Literate to the Population 5,841,540,000 : 7,038,000,000		
Cannot read and write			

Education

	Approx. Current Population	Proportion	if the world were 100 people...
Have secondary education	4,574,700,000		
Have college degree	492,660,000		

Drinking Water

	Approx. Fraction of Population	Proportion	if the world were 100 people...
Access to safe drinking water			
Unsafe drinking water	1,573/12,100		

Poverty

	Approx. Current Population	Proportion	if the world were 100 people...
Malnourished	1,055,700,000		
Live on less than \$2 a day	3,378,240,000		

Technology

	Approx. Fraction of Population	Proportion	if the world were 100 people...
Have Electricity	39/50		
Do Not Have Electricity			
Cell Phone Users	3/4		
Internet Users	3/10		
Computer Owners	11/50		



Fair Trade

If you look at the tags on your clothes or labels on your food, you'll realize the world provides most of your basic needs. While some may take this for granted, it's important to know that many of the growers and producers of these products live in utter poverty. Some

work day and night for less than a dollar an hour. Multinational corporations have been known to take advantage of these growers and producers to increase their profits. In some cases, this allows them to lower prices for consumers, but at what expense?

Fair Trade aims to alleviate poverty in developing countries by ensuring that the growers and producers always will receive a living wage that covers all of their business expenses and provides them with an appropriate cost of living. Of course, if a product is a Fair Trade product, it will be more expensive on the shelf, but is it worth it? In this assignment, you will explore.

Use non-Fair trade and Fair trade values to complete the table.

Item	Non-Fair Trade	Fair Trade	Price Difference	Percent Increase
Bananas	\$0.61 / lb	\$0.86 / lb		
Cocoa	\$1.62 / lb	\$3.42 / lb		
Coffee	\$5.55 / lb	\$6.36 / lb		
Cotton	\$0.76 / lb	\$1.23 / lb		
Orange Juice	\$2.73 / 12 oz	\$4.21 / 12 oz		
Sugar	\$0.67 / lb	\$1.02 / lb		
Tea	\$1.70 / lb	\$2.28 / lb		

1. Which product has the greatest percentage of price difference? The least?



2. What would the price difference be if you bought 5 pounds of Fair Trade sugar instead of 5 pounds of non-Fair Trade sugar?

3. What would the price difference be if you bought 36 oz of Fair Trade orange juice instead of 36 oz of non-Fair Trade orange juice?

4. What would the price difference be if you bought the shopping list of Fair Trade items instead of non-Fair trade?

Shopping List

2 lbs of bananas

4 lbs of cotton

12 oz of orange juice

5 lbs of tea

10 lbs of cocoa

5. A multinational grocery store places a purchase order for 10,000 pounds of bananas. How much more would this cost if they purchase Fair Trade items? If they typically sell bananas as \$0.90 / lb, how much more would they need to sell the bananas for to recoup the difference?
6. A multinational clothing manufacturer needs 40,000 pounds of cotton for the next fashion line. How much more would this cost if they purchase Fair Trade items? If they typically sell 20,000 shirts for \$20 apiece, what would the new price of the shirt be to make up the difference?

Microlending

In some of the poorest areas of the world, one of the challenges is having access to financial services. Typical loans require minimums far above the need of most individuals and those without credit history or a bank account have little opportunity to secure one.



Microloans are a financial service that involves loaning small amounts of money to the poor. The recipients can then invest in business, basic household needs, or education and repay the loans back with interest. The largest Microloan organization, Kiva, has administered over 250 million loans and currently boasts a repayment rate of 99%.

Use the information for each recipient to help answer questions about their loan.

PANHA
Cambodia

A loan of \$750 helps Panha start a bicycle repair business.

35% raised




BACKGROUND

Panha is eighteen years old and is supported his three younger siblings. Panha has an ability to fix machines. He wants to start a business to help pay for the needs of his family and pay his own way to go back to school.

Questions

1. With 35% of his total risen, how much more money does Panha need for the loan to be fulfilled?

Repayment Term	8 months
Expected Repayments	\$95.25 / mo.
Country	Cambodia
Currency	Riel (KHR)
Exchange Rate	4,278.71 KHR = 1 USD
	

2. If Panha makes all of his expected repayments on time, how much money does he pay back overall? How much interest was he charged?

3. What percentage of the original loan did Panha pay in interest?

4. Panha expects to earn 9,000,000 riel this next year. How much does he have left over after paying the loan back? If school costs 500,000 riel will he have enough to go?

Juana

Peru

A loan of \$1215 helps Juana make improvements to her home

8% raised



BACKGROUND

Juana, 51, lives in Lima with her husband and four kids. Unfortunately, she needed to work at a very young age to support her parents and did not finish primary school. She runs her small business selling chichi, a sweet Peruvian drink. She wants to install metal sheets on the roof of her house to provide greater security for her family.

Repayment Term	x months
Expected Repayments	264 PEN / mo.
Country	Peru
Currency	Nuevos Soles (PEN)
Exchange Rate	2.6240 PEN = 1 USD

Questions

- With 8% of her total risen, how much more money does Juana need for the loan to be fulfilled?
- If Juana's loan charges 25% of the original loan value every year in interest (simple interest), how much interest does Juana have to pay each month?
- Write an equation to represent Juana's debt for m months. _____
- If Juana plans to pay 264 PEN a month, how many dollars is this?
- How many months will she need to repay the loan?



Amadou

Mozambique

A loan of \$420 helps Amadou purchase chicks, vitamins, feed and vaccines.

\$256 raised



BACKGROUND

Amadou is married and has two children, both who attend school. He is an animal health technician and has a business of raising and selling chickens. With the loan, Amadou intends to stock up on merchandise to help further develop his poultry business.

Repayment Term	x months
Expected Repayments	25% of profit / mo.
Country	Mozambique
Currency	Meticais (MZN)
Exchange Rate	27.85 MZN = 1 USD

Questions

- With \$256 of the total loan, what percentage of loan has Amadou raised so far?
- If Amadou's loan charges 28% of the original loan value every year in interest (simple interest), how much interest does he have to pay each month?
- Write an equation to represent Amadou's debt for m months. _____
- Amadou projects to profit \$200 a month with his business. If he plans to use 25% of his profit to pay back his loan, how much will he pay each month?
- Write an equation to represent Amadou's payment for m months. _____
- How many months will he need to repay the loan?

Kochi

India

A loan of \$950 helps Kochi pay for four new sewing machines and fabrics for her tailoring shop

\$95 to go!



BACKGROUND

Kochi is a 27-year-old divorced woman living with her sick parents. With one sewing machine, she earns 4,000 rupees a month as a seamstress, but it is not sufficient to help her family. With more sewing machines she can take more orders and can give jobs to her unemployed sisters.

Repayment Term	12 months
Expected Repayments	\$ x / mo.
Country	India
Currency	Rupees (INR)
Exchange Rate	55.6598 INR = 1 USD



Questions

1. With only \$95 of the loan remaining, what percentage of loan has Kochi raised so far?

2.

Debt		Projected Revenue	
Total Loan	52,877 rupees	Monthly sales	10,000 rupees
Interest per Month	1,000 rupees		

Use the table to write an equation to represent Kochi's Total Debt

Use the debt equation to complete the table

Number of Months	Total Debt (in rupees)
1	
6	
12	

Write an equation to represent Kochi's Projected Monthly Revenue.

Use the revenue equation to complete the table

Number of Months	Total Revenue (in rupees)
1	
6	
12	

3. If Kochi chooses to pay her loan back over 12 months, what will her monthly payment be? What percentage of her projected monthly revenue is this?

Microlending

The incredible thing about microlending is that pretty much anyone can participate (well, you will need a bank account). At Kiva.org, you can see the thousands of applicants waiting for a microloan and the countless testimonies of the life changing impact that these loans have had. Take Action!



1. One of the greatest challenges is encourage people to Take Action. How might you as an individual take part in a Microloan? Would you involve others?
2. Suppose you have an extra \$100 lying in the couch cushions and you make the decision to start microlending. You have to choose between Panha, Juana, Amadou and Kochi. Who do you decide? How do you decide? Do you donate some to each of them? All to one of them? Explain.
3. Using Kiva.org, find an applicant that you want to donate money to. Why did you choose this person? Where do they live? What do they need the money for?